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Climate change adaptation policies and plans: A survey in 11 South East European countries

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ABSTRACT

Building a climate-ready adaptation society is an urgent question that cannot be postponed. Along the path towards an increase in climate resilience, a stimulating role is played by EU projects as well as by international climate networks such as the Covenant of Mayors Initiative on Climate Change Adaptation (Mayors Adapt), launched in 2014, and the new Covenant of Mayors for Climate and Energy which "pledge to reduce CO_2 emissions by at least 40% by 2030 and to adopt an integrated approach to tackling mitigation and adaptation to climate change". These initiatives stimulate engagement and networking among cities and raise public awareness encouraging policy makers to take action to adapt to climate change. Adaptation operates at different spatial and societal scales. Accordingly, the development of climate change adaptation strategies requires a holistic and multi-perspective approach with scale-specific studies.

This paper provides an overview of adaptation initiatives undertaken in 11 South East European countries participating in the SEE OrientGate project, with reference to the policies and measures promoted by the EU and implemented at national level. In particular, a cross-sectoral policy analysis is performed and an inclusive representation of measures and policies undertaken by countries with an interdisciplinary approach is provided. The analysis of the country measures reveals that unless national governments and local communities are concerned with the impacts of climate change only few of the countries included in the analysis have developed a comprehensive National Adaptation Strategy and a National Action Plans. Nevertheless, almost all the countries have undertaken adaptation actions across sectors. Although these actions have only partially generated a full commitment towards climate adaptation, they attest an increasing awareness as well as a high involvement of national and local authorities that will boost cooperation among stakeholders to find out innovative solutions to strengthen society and protect the environment.

1. Introduction

The IPCC's Fifth Assessment Report-AR5 [1] confirms unequivocally global warming and provides evidence of its substantial and wide-ranging consequences. Permafrost melting, heavy precipitations, floods, droughts, wildfires are some of the most significant effects caused by climate change that are likely to increase over time and can deeply affect both environment and society. As a matter of fact, hydro-meteorological and geophysical hazards triggered by climate change are becoming increasingly frequent causing severe damages to ecosystems, people and infrastructures. The climate change challenge calls therefore for strong actions and international cooperation to counteract its worldwide dangerous effects. Since 1992, with the birth of an international treaty, the United Nations Framework Convention on Climate Change - UNFCCC, national governments were urged to put in place manifold strategies to limit the average global temperature increase and curb the unavoidable impacts.

However, despite the global huge commitment achieved by the Paris Agreement, during the 21° session of the Conference of the Parties to the United Nations Convention (COP21), countries' pledges are still not enough to face the climate change challenge [2,3]. In fact, as also underlined by [1,4,5] a comprehensive portfolio of climate change strategies must include both mitigation and *ad hoc* adaptation actions that allow achieving multiple goals in the sustainable development areas.

While mitigation have been a preferred option for a long time, adaptation has caught an increasing interest since 2001 when the IPCC *WGII Impacts, Adaptation, and Vulnerability* in the Third Assessment Report [6] highlighted the "sensitivity, adaptive capacity, and vulnerability of natural and human systems to climate change, and the

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Table 1
EU-28 climate and energy policy [21–23].

EU policy milestones	GHGs reduction (compared to 1990 level)	Renewable energy	Energy efficiency
2020 *20–20–20 strategy*	20%	At least 20% share in gross final energy consumption	Reducing energy consumption by 20% compared to projections
2030 *2030 policy framework*	40%	At least 27% of final energy consumption	At least 27% energy savings compared with the business-as-usual scenario
2050 *Energy roadmap 2050*	80% with a 60% by 2040	High RES scenario[a]: – 75% share of RES in gross final energy consumption – 97% share of RES in electricity consumption	30% less energy in 2050 than in 2005

[a] Seven possible scenarios have been selected.

potential consequences impacts of and vulnerability to climate change".

It should be also taken into account that adaptation is a site-specific problem with a cross-sectoral dimension strongly dependent on the climatic, environmental, social, and political conditions [7,8]. Further elements of difficulty are then represented by the high level of complexity, uncertainty, and the long time frame of the involved phenomena [4,9–12] and their unpredictable major consequences on the anthropogenic activities and the related economy. Therefore, the policy response should integrate essentially: (i) mitigation-labeled efforts to reduce directly and indirectly anthropogenic greenhouse gas emissions (i.e. decarbonising the energy sector, decreasing the non-CO_2 greenhouse gas emissions from agriculture, increasing CO_2 sinks - afforestation and use of CCS technologies); and (ii) adaptation processes and practices addressed to increase the climate resilience of vulnerable systems and territories moderating potential damages and taking advantages of new opportunities [6–8]. Accordingly, adaptation and mitigations strategies should be mainstreamed and systematized into decision making processes at all level of governance [7,8,13]. In this context, a multisectoral approach can ensure a better 'horizontal' integration across sectors within and beyond the environmental domain, and promotes a close collaboration of experts, local governments, citizens and other relevant stakeholders [7]. To this end, a fundamental organisational issue is represented by the harmonization of mitigation and adaptation policies at national, regional and local level as well as their integration into sectoral and spatial plans [2,8].

In recent years, adaptation has become a priority in the political agendas encouraging the proliferation of adaptation strategies and plans.

According to EEA [14], the following definitions apply to National Adaptation Strategies (NAS) and National Action Plans (NAP):

- *National Adaptation Strategy (NAS)* as "a broad policy document that outlines the direction of action in which a country intends to move in order to adapt to climate change" ([14] p. 68).
- *National Action plan (NAP)* as "a more detailed document providing a roadmap for the implementation of specific adaptation actions that are being planned" ([14] p. 68).

The increasing interest in adaptation is confirmed by a relevant number of documents in literature aimed at taking the stock of the situation in different contexts. Biesbroek et al. [15] assessed the existing national adaptation strategies in Europe (NAS) emphasising a general "new political commitment to adaptation at national policy levels" and highlighted the differences among countries and the barriers towards the full implementation of adaptation measures. According to Preston et al. [16] the number of adaptation plans in the USA, Canada, and UK had an exponential growth increasing from 2 to 62 in the period 2000–2008.

In this framework, the OrientGate project, funded by the South East Europe Transnational Cooperation Programme (2012–2014) and aimed at fostering the implementation of concerted and coordinated climate adaptation actions in this part of Europe, performed a thorough analysis of the sectoral adaptation actions, measures and policies undertaken by national governments on a selection of 11 South East European (SEE) countries.

The main objective of this study was to systematise the fragmentary knowledge and provide up-to-date information to researchers and policy makers on the state of the art of adaptation strategies in the SEE countries in order to allow their broader comparison and eventually improve the current NAS.

In the next paragraphs, the European policy framework on mitigation and adaptation is introduced including an overview of the initiatives at country level, then a survey carried out in the framework of the OrientGate project on 11 SEE countries is presented with a focus on adaptation. The research findings are thus discussed with reference to the actions undertaken by national governments to increase the resilience of territories and the level of integration of adaptation concepts in national policies, with a short analysis of policy indexs available to compare and evaluate climate change national efforts.

2. The climate change challenge for Europe

The European Union is at the forefront of the climate change challenge as demonstrated by its huge engagement in leading global efforts either to drive the transition towards a low-carbon economy and to prevent and limit the consequences of climate change. In fact, climate change and related impacts can increase existing territorial vulnerability and deepen socio-economic imbalance in Europe with high damage costs [1,17–19].

The European Union has committed itself to limit global average temperature increase to less than 2 °C compared to pre-industrial levels [20] signing the Kyoto Protocol agreement in 1998 and setting ambitious mitigation goals to be achieved in 2020 and 2030 (Table 1). The long-term goal is cutting greenhouse gas emissions by 80–95% by 2050 compared to 1990 levels, to be achieved with increasing targets for the developed countries as a group. In line with this perspective, the Energy Roadmap 2050 [21] explores the energy systems transition necessary to achieve these reductions targets while considering energy competitiveness and security.

As aforementioned, **mitigation and adaptation** represent two complementary aspects of climate change which need to be addressed through a holistic approach [3]. On the one hand, mitigation has long been considered a priority for Europe and is currently addressed by a structured energy policy, on the other hand, the urgency to make regions and cities more resilient to climate change hazards is gaining momentum and adaptation is more and more becoming a key issue.

With the Green Paper "Adapting to Climate Change" [24] and later with the White Paper "Adapting to climate change: Towards a European framework for Action" [25], the EU laid the foundation for the construction of a Community policy framework on adaptation, identifying the impacts and related vulnerabilities to climate change and setting out a number of measures to enhance its resilience. The

Table 2
Overview of the national Adaptation policy framework in 33 European countries (as of August 2014).

Country	NAS	NAP	Web Portal
Austria	Yes 2012	Yes 2012	Yes [30] (German and English)
Belgium	Yes 2010	Yes	Yes [31] (French)
Bulgaria	Under development	Under development	n/a
Croatia	Under development	Under development	Yes [32] (Croatian and English)
Cyprus	Under development	Under development	Yes [33] (Greek and English)
Czech Republic	Yes 2015	Yes 2017	Under development
Denmark	Yes 2008	Yes 2012	Yes [34] (Danish and English)
Estonia	Yes 2016	Yes 2016	Yes [35] (Estonian and English)
Finland	Yes 2005	Yes 2011	Yes [36] (Finnish, Swedish and English)
France	Yes 2006	Yes 2011	Yes [37] (French and English)
Germany	Yes 2008	Yes 2011	Yes [38] (German and English)
Greece	Yes 2016	Yes *(only desertification)* 2001	Under development
Hungary	Yes 2008	Yes 2009	Yes [39] (Hungarian)
Iceland	n/a	n/a	n/a
Ireland	Yes 2012	Under development	Yes [40] (English)
Italy	Yes 2015	Under development	Yes [41] (Italian)
Latvia	Under development	Under development	Under development
Liechtenstein	Under development	Under development	n/a
Lithuania	Yes 2012	Yes 2012	Under development
Luxembourg	Yes 2012	n/a	n/a
Malta	Yes 2012	Yes 2012	Planned to be developed in the future
Netherlands	Yes 2007	Yes 2007	Yes [42] (Dutch, English and Spanish)
Norway	Yes 2013	Yes 2006	Yes [43] (Norwegian and English)
Poland	Yes 2013	Under development	Yes [44] (Polish and English)
Portugal	Yes 2010	n/a	Yes [45] (Portuguese and English)
Romania	Yes 2013	Yes 2013	Under development
Slovakia	Yes 2014	n/a	Yes [46] (Slovak)
Slovenia	Yes (*only Forestry and Agriculture)* 2008	Yes (*only Forestry and Agriculture)* 2008	Yes [47] (Slovenian and English)
Spain	Yes 2009	Yes 2009	Yes [48] (Spanish)
Sweden	Yes 2009	Yes 2009	Yes [49] (Swedish and English)
Switzerland	Yes 2012	Yes 2012	Yes [50] (German, French and Italian)
United Kingdom	Yes 2013	Yes 2013	Yes [51] (English)

launch of the **Strategy on Adaptation to Climate Change** [26] in 2013 complemented the European adaptation framework providing EU policy makers with comprehensive guidelines on the process of developing, implementing and reviewing adaptation strategies to face climate change.

Nowadays, according to the European Commission guidelines, the majority of the EU Member States have defined and implemented comprehensive adaptation strategies, identifying suited measures and interventions to reduce the impacts of climate change on the most vulnerable sectors.

Adaptation is a dynamic process in which European countries have been increasingly involved. Table 2 summarises the state of the art in 33 European countries concerning the NAS and NAP policy documents as well as the implementation of national web portals on adaptation aimed at informing policy makers, citizens and stakeholders on national adaptation initiatives. Table 2 gathers and summarizes the information reported by the EEA [14,27], the Climate-ADAPT platform [28] and the POLIMP project [29].

As reported in Table 2, the first adaptation strategy in Europe was developed in Finland in 2005. The early strategies were rather general, but after less than a decade a more inclusive approach was adopted (e.g. United Kingdom), implementing and integrating adaptation measures into local sector-specific plans and subsequently combining them under a common framework [26,52].

Nowadays about 76% of the European countries have adopted a NAS and 61% have developed a NAP. Twenty-two web platforms are also available all over Europe, eight of which (Austria, Denmark, Finland, Germany, Norway, Sweden, Switzerland and UK) are more inclusive and directly connected to the implementation of a national adaptation strategy and/or action plan. However, the pioneer countries paved the way for the diffusion of adaptation strategies providing an exemplary guide for other countries [52].

3. A survey on climate adaptation strategies in the SEE countries

A systematic survey on climate adaptation strategies in the SEE countries was performed in the framework of the OrientGate project aimed at gathering information on the status of adaptation policies and encouraging the exchange of knowledge and experience on these issues in territorial planning.

In particular, an in-depth analysis of the national policy framework on adaptation was carried out in the 11 partner countries: **Austria (AT), Bosnia and Herzegovina (BiH), Bulgaria (BG), Croatia (HR), Greece (GR), Hungary (HU), Italy (IT), Romania (RO), Serbia (RS), Former Yugoslav Republic of Macedonia (FYRM) and Ukraine (UA)**. These countries cover an area of strategic importance either concerning territorial vulnerability to climate change and associated risk. Moreover, there is a general scarcity of a written documents, studies and information in English on the adaptation policies and strategies in these countries.

Table 3
Template to collect the information about Climate Change Adaptation (CCA) actions by thematic area.

Thematic centres	Key sectors	Example of CCA actions
Forest and Agriculture		
	Hydrogeology	Measures to prevent floods, landslide, etc.
	Forests	Fire protection, adaptive forest management, etc.
	Agriculture	Irrigation water demand reduction, etc.
	Other	
Drought, Water and Coasts		
	Drought	Interventions to reduce the vulnerability to desertification, etc.
	Coastal and marine systems	Strategies for adapting to sea-level rise, etc.
	Water management	Sustainable use of water resources, etc.
	Other	
Urban Adaptation and Health		
	Human health	Adaptation to extreme meteorological events: heat waves, risk of flooding, etc.
	Other	

3.1. Method

The objective of the proposed survey was to systematise knowledge and get a complete overview on adaptation policies in a pool of eleven countries of great territorial relevance for which only fragmentary information are available.

The project was rooted on three thematic centres (i) **Forest and Agriculture,** (ii) **Drought, Water and Coasts,** (iii) **Urban Adaptation and Health** and the research was aimed to fill knowledge gaps and identify the main barriers that hinder the implementation of climate change adaptation policies and measures.

These three thematic areas, although not exhaustive, were selected as representative of the major effects of climate change in South East European countries. Per each thematic centre a set of key sectors was identified and a common methodology was devised and applied in the selected case studies.

As a preliminary task, a review of national adaptation strategies (NAS), action plans (NAP) and other sectoral measures (not specifically developed under the adaptation umbrella) on climate change adaptation (CCA) was performed according to a common template reported in Table 3.

In the proposed approach, each partner was asked to fill in the survey template reporting on the specific measures foreseen in their adaptation strategies and plans to face the impacts in the three selected areas. The first round of the survey was held in spring 2013 and the second round in spring 2014.

4. Results

The review on national strategies and plans highlighted that 7 out of 11 countries have approved a National Adaptation Strategy (NAS) and/or an Action Plan (NAP) and 5 of them have also a web portal (Fig. 1). Among the investigated countries, Austria and Hungary along with their NAS have defined a roadmap for their implementation in a comprehensive NAP and have also developed a national web portal. Romania, and Greece have adopted a NAS and a NAP whereas FYR of Macedonia and Ukraine have defined only a NAP, Italy has a NAP and it is developing a NAP. As for the remaining countries, Bosnia and Herzegovina, Bulgaria, and Ukraine have started the implementation of a national adaptation strategy whereas Serbia has not yet defined any strategy.

The preliminary analysis of the existing initiatives revealed an increasing awareness at country level on the urgency and the necessity to face climate change. In fact, many sectoral actions and autonomous initiatives pointed out by the survey investigation were undertaken to counteract climate change effects also in the countries that haven't started yet an adaptation strategy.

Besides the reported initiatives, it should be noticed that several programmes were launched in the SEE countries either to mobilize policy makers on adaptation and to support coordination between national, regional and international initiatives.

Among them it is worth mentioning the South East European Forum on Climate Change Adaptation (CCA Forum) [53] that involves 80 members organized in four national networks: Croatia, FYR of Macedonia, Montenegro and Serbia. It was initially developed by "The Austrian, Croatian, Macedonian and Montenegro Red Cross" to focus the humanitarian consequences of climate change in the SEE region. Afterwards, the CCA Forum included also the social, economic and environmental perspective, addressing four different projects: Formation and Mobilization of National Networks on Climate Change Adaptation, Climate Risk Analysis, Training in Communication and Regional Forum on Climate Adaptation.

In this framework, several documents were produced to assess the status of climate change adaptation initiatives and the risks for the territory, among which four Regional Climate Vulnerability Assessment Reports for Croatia, FYR of Macedonia, Montenegro [54] and Serbia [55]. In particular, these documents were aimed at boosting local climate vulnerability research, supporting a structured mobilization and involvement of stakeholders as well as contributing to strengthen a community safety and resilience culture.

Another interesting initiative is the "Southeast European (SEE) Climate Change Framework Action Plan for Adaptation" 2009–2015 [56] funded by the Royal Ministry of Foreign Affairs of Norway. It involved Albania, Bosnia and Herzegovina, FYR of Macedonia, Montenegro and Serbia in a joint effort to provide a common platform for sub-regional cooperation in climate change and to support the development and implementation of a regional adaptation strategy for the Balkans.

Other projects and local programmes were also funded by the EU (e.g. CLISP [57]; AdaptFor [58]; CarpathCC [59]; MEDIATION [60]; RSC [61], etc.) that highly contributed to increase the knowledge on vulnerability and adaptation themes as well as to boost integrated adaptation planning processes in the Southern East European countries.

In the following, the results of the in-depth investigation on thematic initiatives are presented with reference to the 3 thematic centres: (i) Forest and Agriculture, (ii) Drought, Water and Coast, (iii) Urban Adaptation and Health.

4.1. Forest and agriculture

Forests and agricultural lands in different geographical areas of the European Union are highly affected by climate change [62]. In fact, changes in average climate conditions as well as in the atmosphere composition can trigger many and complex effects including deforestation, increased vulnerability of trees to secondary damages such as insect and fungal infestations, drought and wildfires [14]. Similarly, as farming activities are strongly dependent on weather conditions and

water availability, climate change could affect negatively crop productivity by region [14].

As Forest and Agriculture are key sectors for territorial economy many adaptation initiatives have thus been undertaken in the in Southern Europe countries to enhance their resilience, among which:

- reforestation
- afforestation of abandoned areas
- sustainable management of forests and increase of protected areas
- introduction of protective forest belts
- interventions of protection against forest fires
- increased protection of forests against pest, vermin and plant diseases
- biodiversity protection
- diversification of species in agricultural cultivations, change to other species (e.g. later maturing and more fertile crops)
- change of fertilization management by utilization of organic fertilizers
- crop rotations
- water-saving and energy-saving irrigation technologies.

Besides these specific options, the survey results highlighted also the important role of transversal measures that address the social component. To this end, two main issues were tackled by some of the partners: how to increase capacity building of local authorities/ institutions and how to raise stakeholders' awareness (e.g. forest owners, farmers, breeders, citizens).

The results highlighted that in the investigated countries there were many initiatives aimed to put up at the same time specific adaptation measures and community awareness options.

The most interesting initiatives in the framework of national adaptation strategies are briefly described in the following.

In **Austria** the national strategy was addressed "to avoid the adverse effects of climate change on the environment, society, and the economy and to fully utilise any opportunities that may arise" [63]. It was intended to provide recommendations for action in fourteen strategic sectors among which forestry and agriculture. This strategy valorized the outcomes of researches on the effects of climate change in tree species and pest infestations. However, a noticeable operating contribution to adaptation came also from the Austrian Climate Research Programme [64] in which a "Carbon calculator" was developed to support farmers in the optimization of humus-management. Furthermore, information campaigns addressed forest owners in order to provide information on climate change and advice on adaptive tree species more tolerant to changes in environmental conditions.

Financial incentives were granted in **Bulgaria** to farmers in order to boost the use of up-to date technologies (e.g. water-saving and energy-saving irrigation equipment) and in **Ukraine** to encourage risk insurance in Agriculture.

In **Hungary** the National Climate Change Strategy addressed enhanced plant breeding activities to help the use and the spreading of more resistant species.

In **Italy**, the strategies addressed mainly land degradation with reference to reforestation for the recovery of erosion hazardous territories and land reclamation of industrial sites. In fact, due to the high hydrogeological risk, soil protection and hydrogeological risk reduction were considered top priorities.

In **FYR of Macedonia** the salt-rich groundwater level was controlled by reducing the amount of surface and groundwater and drainage of micro-depressions in the valleys.

In **Serbia** a multidisciplinary approach was adopted to devise and implement adaptation strategies aimed at increasing forest resilience to climate change. Furthermore, both in **Serbia and Croatia** public awareness was considered a key issue and many initiatives were put in place to increase capacity building while facing climate change impacts. These aimed at strengthening the role of local communities in sustainable forest management, increasing the capacity of farming community and improving advisory services for crop selection.

4.2. Drought, water and coasts

According to the projections of IPCC scientists, climate change will have a noticeable impact on water resources with a wide range of effects. Changes to the hydrologic cycle as well as to the amount, timing, form, and intensity of precipitation will lead to an increased risk of floods in Northern, Central and Eastern Europe whereas droughts will be more frequent in Southern Europe [62].

From a hydrogeological point of view, global coastal areas will be significantly affected being more vulnerable to sea level rise, changes in precipitation, warmer ocean temperatures as well as salinization of groundwater and the increase of acidity due to the increase of CO_2 concentrations that concern both ecosystems and coastlines [62].

Furthermore, salt-water intrusion into freshwater reservoirs caused by sea-level rise and overexploitation of groundwater resources can lead to depletion of freshwater reservoirs with relevant consequences on ecosystems, human activities and the economy with significant impacts on agriculture, energy production and industry [19].

A wide range of measures were deployed in the SEE countries to stem the damages of climate change on coastal areas and allow a better management of water resources.

Many initiatives were undertaken by national governments on flooding events prevention and water resources management, aimed at increasing the resilience of the territory, among which:

- Development of vulnerability and flood risk maps and management plans,
- Individuation of flood prone areas and evaluation of loss of retention space and potential damage,
- Improvement of flood resistance systems (dams, river basin management, …),
- Implementation of public flood warning systems and evacuation procedures from lowlands,
- Development of concepts for compensation measures,
- Reduction of the alterations and anthropic influence in the geomorphology of drainage basins,
- Minimization of conflicts between different end-users, agriculture and public water supply with structural interventions to improve the water supply infrastructures efficiency and reduce the losses and reconversion of irrigation systems,
- Water quality monitoring.

As concerns more specifically coastal defence and valorisation, interventions and measures to reduce flooding and erosion as well as coastal habitat vulnerability and environmental degradation were undertaken. Moreover, to increase communities' safety and tourist attractiveness of coastal areas, additional measures were taken such as building of artificial reefs, nearshore breakwaters, artificial channelling and drainage, sand feeding of high-profit tourist areas as well as improving recreational facilities by implementing customised management strategies.

As concerns drought, many actions were foreseen in the investigated countries to cope with this problem, the most interesting one are briefly reported in the following.

In **Italy**, the "National Action Plan to combat Drought and Desertification" entrusted regional governments and watershed authorities with the responsibility to implement specific agronomic, forest, civil and social measures and adopt information, training and research programmes, providing them with a coherent set of interventions aimed at reducing the vulnerability to desertification.

In **Romania**, the "National Partnership Agreement for the 2014–2020 Programming Period" underlined the need to improve national monitoring and management policies in order to improve preparedness

and reduce drought impacts. This improvement addresses two main topics:

- *Monitoring and prediction,* to contribute to a broad early warning system;
- *Mapping and assessing,* to evaluate the impact of droughts, promote best practices, and develop infrastructures for irrigation taking advantage from scientific knowledge advancements (climatic data, soil and crops data).

It is also worth mentioning the Water Restriction Plan elaborated in **Bulgaria** that implemented an informational and decision-making system along with an alarm system for the population and socio-economic entities at the level of single basin, in order to allow a better management of water shortage. In this framework, a list of users with different needs and priorities was also identified to ensure them a minimum amount of water flow.

4.3. Urban adaptation and health

More than two thirds of European population live in urban areas, a share that is expected to increase further in the future [19]. As centres of population and economic activity, cities are particularly vulnerable to climate variability [65]. Moreover, their urban design alters climate change impacts, exacerbating some effects such as heat waves, urban floods caused by a high percentage of impervious surfaces and water scarcity due to the high concentration of people and socio-economic activities [19].

In this framework, it should be also considered that extreme weather events such as heat waves and windstorms, floods and droughts, and storm surges have a proven strong impact on human health.

Therefore, cities can be pivotal for the adaptation to global climate change and can play a leading role in the transition towards a sustainable future [66].

Accordingly, a wide range of adaptation measures has been implemented in the SEE countries to tackle the problems related to climate change in urban areas, addressing both monitoring and information services and infrastructures. A selection by theme is presented in the following:

- *adaptation to extreme hydrological events* (heavy rainfall events, floods,..): detailed climate change vulnerability assessment, health early warning system especially for vulnerable groups;
- *adaptation to heat waves*: monitoring of events, early warning system, installation of drinking water standpipes in public spaces, inclusion of climate change issues in spatial and urban planning to reduce heat island effects, initiatives to inform and advise citizens (e.g. a National Call Centre, booklets for advice, website and special TV programmes), definition of strategies and procedures to protect more vulnerable population.

As an example, 80% of the new buildings in the city of Linz (Austria) were equipped with green roofs that allow achieving a good insulation both from heat (the temperature decreases 30–60% below the temperature of normal roofs) and cold, reducing noise, pollution and storm-water runoff at lower maintenance and operation costs.

Many voluntary initiatives on urban adaptation and health were also undertaken by different cities in the investigated countries fostered by their participation in EU funded initiatives [66]. Among these, it is worth mentioning the commitment of some Italian cities to develop comprehensive adaptation plans [67-69]. Padova and Reggio Emilia developed their climate plans (2011) in the framework of the EU LIFE-LAKS project [70], Ancona adopted its Local Adaptation Plan developed in the framework of the EU LIFE ACT project [71], and Bologna approved its adaptation plan developed in the framework of the EU LIFE-BlueAp project [72].

In this framework an important role is also played by the Mayors Adapt initiative [73], built on the successful structure of the Covenant of Mayors[1] [74]. It was launched in 2013 in the framework of the EU adaptation strategy, with the overall aim to promote urban leadership in adaptation and to provide cities with an extensive support for local activities addressed to increase climate change resilience.

Mayor Adapt and Covenant of Mayors have recently merged (October 2015) and the new Covenant of Mayors for Climate and Energy [75] announced as the “world's biggest urban climate and energy initiative” in which thousands of local and regional authorities cooperate voluntarily to achieve the EU energy and climate targets by integrating mitigation and adaptation issues. This initiative is expected to gather growing interest of local authorities to facilitate the operational integration of climate adaptation concepts in urban planning.

4.4. An overview in our sample

The review of climate adaptation policies in the SEE OrientGate partner countries (Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, Italy, Romania, Serbia, Former Yugoslav Republic of Macedonia and Ukraine) highlighted that although inclusive national adaptation strategies have not yet defined in all the countries, specific measures and actions addressing more vulnerable sectors have been defined at local level and integrated in other territorial strategies. Results show also that the three OrientGate thematic centres (Forest and Agriculture, Drought, Water and Coasts, Urban Adaptation and Health) are addressed either by country policies and local plans, with specific differences related to different geographic conditions (Fig. 2).

This investigation also pointed out, as a main drawback, the lack of a common structured framework that integrate energy, climate, adaptation and urban planning issues. In fact, a cross-sectoral vision drives the action strategies in the countries where a national adaptation strategy is already in place (e.g. Austria and Hungary).

5. Policy evaluation

Assessing the efforts of countries in climate policy is one of the main aim of different studies in scientific literature (e.g. [76]). The measurement of countries' climate policy performance is important for supporting policy-making process as well as to raise public awareness on environmental issues [77].

Most of the studies developed so far are aimed to assess progress toward the reduction of greenhouse gas emissions and the mitigation of their impact. To this regard, the related set of indicators are simply based on greenhouse gas emission levels and/or rates of change to compare states. As pointed out by Bernauer and Bohmelt [78] “this approach does not fully capture a country's overall climate policy performance; focusing on emissions does not automatically tell us how strict or ambitious the climate policy of a given country is, since emissions are also affected by factors other than policy (e.g. economic developments or the weather)”.

Among the available policy indicators, the Climate Change Performance Index (CCPI), published every year by Germanwatch since 2006 [79], evaluates and compares the climate protection performances of 58 countries that are, together, responsible for more than 90% of global energy-related CO_2 emissions.

The CCPI index combines indicators related to: emissions level (30% weighting), development of emissions (30% weighting), renewable energy (10% weighting) and Climate policy (20% weighting).

Battig et al. [80] estimate and compare the cooperative behavior of countries within the international climate change regime through a set

[1] Network of European Mayors launched in 2008 by the European Commission after the adoption of the EU Climate and Energy Package with the aim to endorse and support the efforts deployed by local authorities in mitigating the effects of climate change.

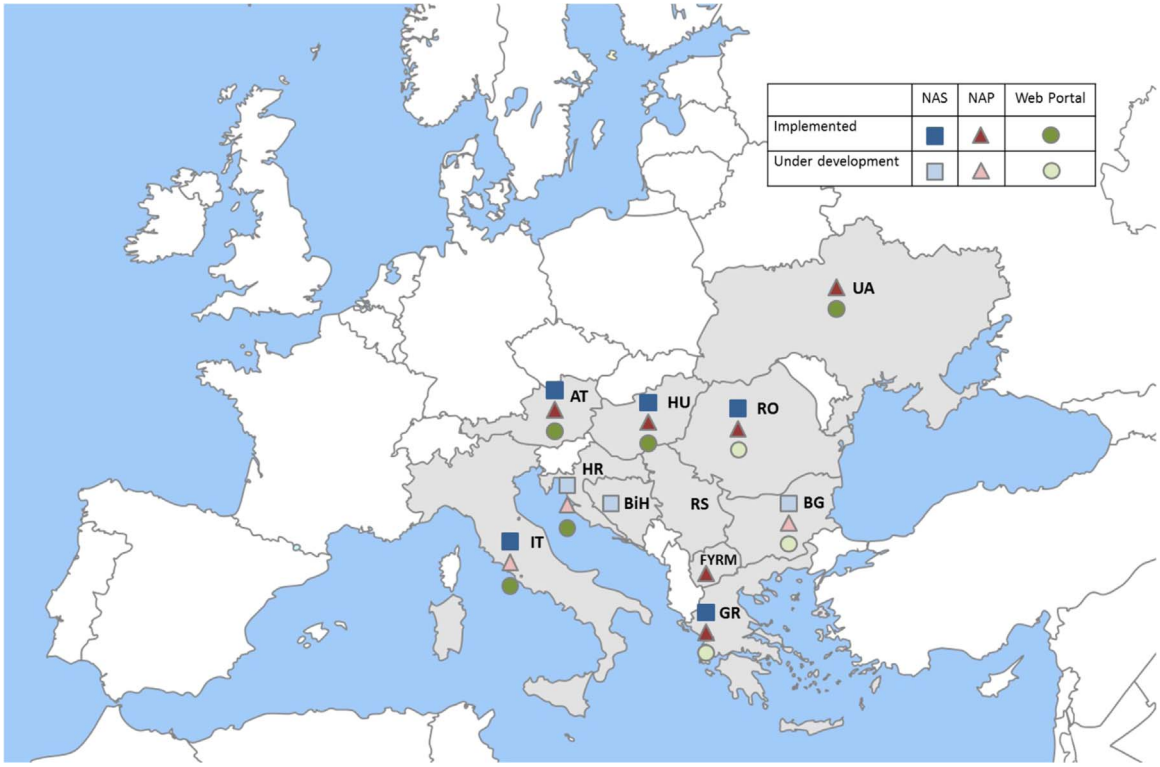

Fig. 1. Status of implementation of National Adaptation Strategies (NAS), National Action Plans (NAP) and Web portal in the SEE countries (on the basis of the EEA[2] report [14] and the data provided by the OrientGate project partners).

of five indicators (two of them measuring countries commitments to the United Nations Framework on Climate Change (UNFCCC) and the Kyoto Protocol) and three indicators quantifying "whether and how effectively measures have been implemented in line with these agreements" plus an aggregated Cooperation Index (CI) that evaluates 198 countries' cooperative behavior within the international climate regime.

In addition, Bernauer and Böhmelt [78] developed a Climate Change Cooperation Index (C3-I) for up to 172 countries for the time period 1996–2008 which "captures overall performance as well as performance in terms of political behavior (output) and emissions (outcome)". Some other studies focus on the application of indexes to evaluate climate policies based on exergetic analysis (see e.g. [81]). They demonstrate the effectiveness of this procedure in supporting both policy planning and resource management.

In Table 4 both the CCPI and the CI for the eleven Southern European countries in our sample are reported. A comparison among these index is depicted in Fig. 3.

6. Discussion and conclusions

The high level of complexity, uncertainty, and the long time frame of processes triggered by global warming require a strategic comprehensive planning approach to ensure the effectiveness and coordination of climate strategies as well as to promote cooperation among the different institutional bodies.

Improving the approach to adaptation represents therefore a new challenge for scientific research that should be faced by integrating policy, technical and social components. Particular efforts should be addressed to improve the scientific knowledge, the decision-making mechanisms and to foster an active stakeholder engagement to cooperate for the achievement of common goals.

In this framework an important point is to raise citizens' awareness and preparedness towards the dangerous effects of climate change. In this context, adaptation has a key role and is currently a worldwide main concern in the policy agendas. The majority of governments as well as Local Authorities have acknowledged the importance of facing extreme weather events with a precautionary approach due to their multiple and complex effects on environment, human life and infrastructures. Adaptation strategies, even if in a fragmented way have become increasingly popular. As concerns Europe, the sound framework on energy and climate, mainly focused on mitigation, is complemented by several documents on adaptation that encourage countries to implement their national adaptation strategies. Currently 26 out of 33 European countries have already defined a NAS and 5 are developing them, whereas NAPs were implemented in 19 countries.

As in climate change mitigation, EU sponsored initiatives (e.g. [53,73]) as well as EU Transnational Cooperation Programmes contribute noticeably to encourage and support policy makers in undertaking concrete initiatives.

Some general considerations arisen from this analysis can be useful for the definition of adaptation strategies:

1. A close cooperation among all stakeholders involved in the adaptation processes is required to build a broad consensus on adaptation strategies;
2. Raising awareness and improving local authorities, sectoral practitioners and stakeholder's capacities is a key issue to improve resilience;
3. Adaptation actions should be mainstreamed into all relevant policy areas at all levels of governance;
4. Cross-sectoral actions should be promoted to avoid negative side-effects (maladaptation) and to exploit synergies and opportunities;
5. Monitoring and information systems should be put in place to improve preparedness, evaluate the progresses and provide feedbacks for re-directing the adaptation strategies.

[2] Bosnia and Herzigovina, Montenegro, Serbia, The Former Yugoslav Republic of Macedonia and Ukraine are not EEA member.

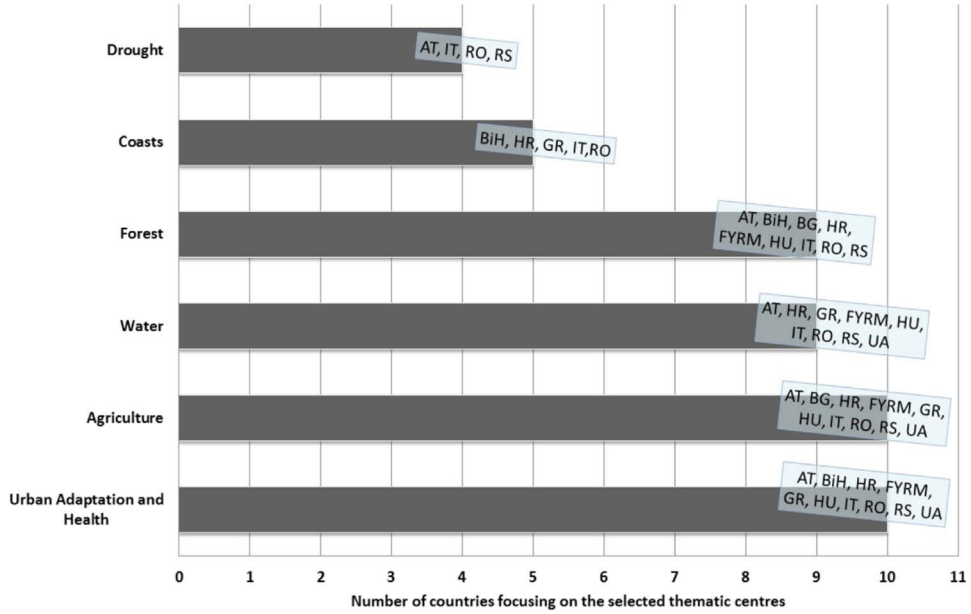
Drought
Coasts
Forest
Water
Agriculture
Urban Adaptation and Health
AT, IT, RO, RS
BiH, HR, GR, IT,RO
AT, BiH, BG, HR, FYRM, HU, IT, RO, RS
AT, HR, GR, FYRM, HU, IT, RO, RS, UA
AT, BG, HR, FYRM, GR, HU, IT, RO, RS, UA
AT, BiH, HR, FYRM, GR, HU, IT, RO, RS, UA
0 1 2 3 4 5 6 7 8 9 10 11
Number of countries focusing on the selected thematic centres

Fig. 2. Priority sectors addressed in the national adaptation actions (mainly based on data provided by OrientGate project partners and derived from [14].

Table 4
Examples of indexes for climate change evaluation.

	ORIENTGATE partner Countries	CCPI 2017 - Climate Change Performance Index	CI - Cooperation Index
1	**Austria**	52	3.73
2	**Bosnia and Herzegovina**	not included	2.03
3	**Bulgaria**	53.06	3.93
4	**Croatia**	60.66	3.24
5	**Greece**	58.29	2.75
6	**Hungary**	55.05	4.26
7	**Italy**	60.72	3.37
8	**Romania**	30.33	4.03
9	**Serbia**	not included	1.71
10	**The Former Yugoslav Republic of Macedonia**	not included	not included
11	**Ukraine**	50.88	2.63

CCPI 2017: The score ranges from a minimum of 0 to a maximum of 100 points.
CI: The score ranges from 0 (=least cooperative) and 6 (=most cooperative).

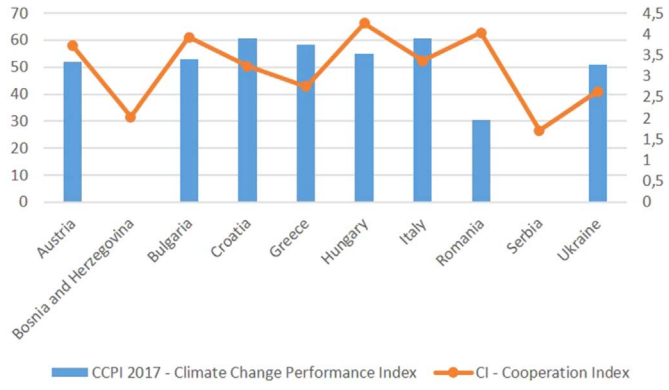

Fig. 3. Comparison of CCPI 2017 and CI.

Author contribution

The study, manuscript preparation and coordination of data collection was led by F.P. who also lead the analysis of the collected adaptation plans and actions. V.K. contributed towards data acquisition in Ukraine. All co-authors contributed both to the preparation of the manuscript and its critical review. Figures and Tables were produced by F.P.

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References

[1] IPCC. Summary for policy makers. in: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the FifthAssessment Report of the Intergovernmental Panel on Climate Change [Field, C. B.,V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2014.

[2] De Bruin K, Dellink RB, Ruijs A, Bolwidt L, van Buuren A, Graveland J, et al. Adapting to climate change in The Netherlands: an inventory of climate adaptation options and ranking of alternatives. Clim Chang 2009;95:23–45. http://dx.doi.org/10.1007/s10584-009-9576-4.

[3] Dewulf A. Contrasting frames in policy debates on climate change adaptation. WIREs Clim Chang 2013;4:321–30. http://dx.doi.org/10.1002/wcc.227.

[4] Cox P, Stephenson D. A changing climate for prediction. Science 2007;317:207–8. http://dx.doi.org/10.1126/science.1145956.
[5] VijayaVenkataRaman S, Iniyan S, Goic R. A review of climate change, mitigation and adaptation. Renew Sustain Energy Rev 2012;16:878–97.
[6] IPCC. Climate Change: Impacts, Adaptation and Vulnerability. Summary for Policy Makers. World Meteorological Organisation, Geneva; 2001. ⟨http://www.ipcc.ch/ipccreports/tar/wg2/index.php?Idp=0⟩ [Accessed 3 June 2016].
[7] Füssel HM. Adaptation planning for climate change: concepts, assessment approaches, and key lessons. Sustain Sci 2007;2009(2):265–75. http://dx.doi.org/10.1007/s11625-007-0032-y.
[8] Adger W, Nigel N, Arnella W, Tompkins EL. Successful adaptation to climate change across scales. Glob Environ Chang 2005;15:77–86.
[9] Quay R. Anticipatory Governance. J Am Plan Assoc 2010;76:496–511. http://dx.doi.org/10.1080/01944363.2010.508428.
[10] Fankhauser S, Smith JB, Tol RSJ. Weathering climate change: some simple rules to guide adaptation decisions. Ecol Econom 1999;30:67–78.
[11] Hawkins E, Sutton R. The Potential to Narrow Uncertainty in Regional Climate Predictions. B AM Meteorol Soc J 2009;90:1095–107. http://dx.doi.org/10.1175/2009BAMS2607.1.
[12] Watkiss P, Hunt A, Blyth W, Dyszynski J. The use of new economic decision support tools for adaptation assessment: a review of methods and applications, towards guidance on applicability. Clim Change 2015;132:401–16. http://dx.doi.org/10.1007/s10584-014-1250-9.
[13] Dupuis J, Biesbroek R. Comparing apples and oranges: the dependent variable problem in comparing and evaluating climate change adaptation policies. Glob Environ Chang 2013;23:1476–87.
[14] EEA Report. N. 3/. Adaptation in Europe. Addressing risks and opportunities from climate change in the context of socio-economic developments; 2013.
[15] Biesbroek GR, Swart RJ, Carter TR, Cowan C, Henrichs T, Mela H, Morecroft MD, Rey D. Europe adapts to climate change: comparing national adaptation strategies. Glob Environ Chang 2010;20:440–50. http://dx.doi.org/10.1016/j.gloenvcha.2010.03.005.
[16] Preston BL, Westaway R, Dessai S, Smith TF. Are we adapting to climate change? Research and methods for evaluating progress. In: Shafer, M.A., Maricle, G.E., Demuth, J., Drobot, S.D. (Eds.), 89th American Meteorological Society Annual Meeting – Fourth Symposium on Policy and Socio-Economic Research, Phoenix, AZ; 2009.
[17] Beniston M, Stephenson DB, Christensen OB, Ferro CAT, Frei C, Goyette S, et al. Future extreme events in European climate: an exploration of regional climate model projections. Clim Chang 2007;81:71–95. http://dx.doi.org/10.1007/s10584-006-9226-z.
[18] Fischer E, Schär C. Consistent geographical patterns of changes in high-impact European heatwaves. Nat Geosci 2010;3:398–403. http://dx.doi.org/10.1038/ngeo866.
[19] EEA Report No 12/2012. Climate Change Impacts and Vulnerability in Europe. An indicator-based report. ⟨http://www.eea.europa.eu/publications/climate-impacts-and-vulnerability-2012⟩ [Accessed 22 June 2016].
[20] COM 2 final. Communication from the Commission to the council, theEuropean parliament, the European economic and social committee and the committee of the regions. Limiting Global Climate Change to 2 °C. The way ahead for 2020 and beyond; 2007.
[21] COM 112 final.Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. A Roadmap for moving to a competitive low carbon economy in 2050; 2011.
[22] Directive/27/EU of the european parliament and of the council of 25 October 2012 on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC; 2012.
[23] COM 15 final. Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030; 2014.
[24] COM 354 final. Green Paper from the Commission to the Council, theEuropean Parliament, the European Economic and Social Committee and the Committee of the Regions - Adapting to climate change in Europe – options for EU action.
[25] COM 147 final. Opinion of the European Economic and Social Committee on the White Paper 'Adapting to climate change: Towards a European framework for action'; 2009.
[26] COM 216 final. Communication from the commission to theEuropean parliament, the council, the European economic and social committee and the committee of the regions. An EU Strategy on adaptation to climate change; 2013.
[27] EEA report. N. 4/. National adaptation policy processes in European countries; 2014.
[28] Climate-ADAPT- European Climate Adaptation Platform. http://climate-adapt.eea.europa.eu [Accessed 16 November 2016].
[29] POLIMP project. ⟨http://www.polimp.eu⟩ [Accessed 24 June 2016].
[30] Adaptation Web Portal of Austria. ⟨www.klimawandelanpassung.at⟩ [Accessed 24 June 2015].
[31] Adaptation Web Portal of Belgium. ⟨http://www.awac.be/index.php/thematiques/changement-climatique/les-actions-chgmt-clim/adaptation⟩ [Accessed 24 June 2015].
[32] Adaptation Web Portal of Croatia. ⟨http://www.mzoip.hr/en/climate/climate-change-adaptation.html⟩ [Accessed 21 June 2017].
[33] Adaptation Web Portal of Cyprus. ⟨http://cypadapt.uest.gr/⟩ [Accessed 24 June 2015].
[34] Adaptation Web Portal of Denmark. ⟨http://en.klimatilpasning.dk/⟩ [Accessed 24 June 2015].
[35] Adaptation Web Portal of Estonia. ⟨http://www.klab.ee/kohanemine/en/⟩ [Accessed 21 June 2017].
[36] Adaptation Web Portal of Finland. ⟨http://ilmasto-opas.fi/en/ilmastonmuutos/sopeutuminen⟩ [Accessed 24 June 2015].
[37] Adaptation Web Portal of France. ⟨http://www.developpement-durable.gouv.fr/The-Observatory-ONERC.html⟩ [Accessed 24 June 2015].
[38] Adaptation Web Portal of Germany. ⟨http://www.umweltbundesamt.de/en/topics/climate-energy/climate-impacts-adaptation⟩ [Accessed 24 June 2015].
[39] Adaptation Web Portal of Hungary. ⟨http://klima.kormany.hu/⟩ [Accessed 24 June 2015].
[40] Adaptation Web Portal of Ireland. ⟨http://www.climateireland.ie/#/⟩ [Accessed 20 June 2017].
[41] Adaptation Web Portal of Italy. ⟨http://www.minambiente.it/pagina/adattamento-ai-cambiamenti-climatici-0⟩ [Accessed 20 June 2017].
[42] Adaptation Web Portal of Netherland. ⟨http://www.knowledgeforclimate.nl/⟩ [Accessed 24 June 2015].
[43] Adaptation Web Portal of Norway. ⟨http://www.miljodirektoratet.no/no/klimatilpasning_Norge/⟩ [Accessed 24 June 2015].
[44] Adaptation Web Portal of Poland. ⟨http://klimada.mos.gov.pl/en/⟩ [Accessed 24 June 2015].
[45] Adaptation Web Portal of Portugal. ⟨http://apambiente.pt/index.php?Ref=16 & subref=81 & sub2ref=118⟩ [Accessed 24 June 2015].
[46] Adaptation Web Portal of Slovakia. ⟨http://www.minzp.sk/sekcie/temy-oblasti/ovzdusie/politika-zmeny-klimy/aktualne-temy/adaptacia.html⟩ [Accessed 24 June 2015].
[47] Adaptation Web Portal of Slovenia. ⟨http://www.arso.gov.si/en/Climat%20change/⟩ [Accessed 24 June 2015].
[48] Adaptation Web Portal of Spain. ⟨http://www.mapama.gob.es/es/cambio-climatico/temas/default.aspx#⟩ [Accessed 20 June 2017].
[49] Adaptation Web Portal of Sweden. ⟨http://www.klimatanpassning.se/⟩ [Accessed 24 June 2015].
[50] Adaptation Web Portal of Switzerland. ⟨http://www.bafu.admin.ch/klima/13877/14401/index.html?Lang=de⟩ [Accessed 24 June 2015].
[51] Adaptation Web Portal of United Kingdom. ⟨https://www.gov.uk/government/policies/climate-change-adaptation⟩ [Accessed 24 June 2015].
[52] Swart R, Biesbroek R, Binnerup S, Carter TR, Cowan C, Henrichs T, et al. Europe Adapts to Climate Change: comparing National Adaptation Strategies. PEER Report No 1. Helsinki: Partnership for European Environmental Research; 2009, ⟨http://www.peer.eu/fileadmin/user_upload/publications/PEER_Report1.pdf⟩, [Accessed 28 June 2016].
[53] CCA Forum. South East European Forum on Climate Change Adaptation. ⟨http://www.seeclimateforum.org/CCA-Forum/1/Home.shtml⟩ [Accessed 18 July 2016].
[54] Whitlock L. Regional Climate Vulnerability Assessment Synthesis Report. Croatia, FYR Macedonia, Montenegro, Serbia. South East European Forum onClimate Change Adaptation (SEEFCCA); 2012. ⟨http://awsassets.panda.org/downloads/regional_cva_synthesis_report.pdf⟩ [Accessed 18 July 2016].
[55] Sekulić G, Dimović D, Kalmar Z, Jović K, Todorović N. Climate Vulnerability Assessment – Serbia. WWF. Belgrade; 2012.
[56] SEE/CCFAP-A. Southeast European (SEE) Climate Change Framework Action Plan for Adaptation 2009–2015. ⟨http://www.seevccc.rs/CCFAP-A/CCFAP-A.pdf⟩ [Accessed 28 June 2016].
[57] CLISP - Climate Change Adaptation by Spatial Planning in the Alpine Space. Interreg Alpine Space Programme (2008–2011) ⟨http://climate-adapt.eea.europa.eu/metadata/projects/climate-change-adaptation-by-spatial-planning-in-the-alpine-space⟩ [Accessed 25 June 2016].
[58] AdaptFor - Adaptation of forest management to climate change in Greece. LIFE+ (2010–2014). ⟨http://en.life-adaptfor.gr/index.php?Id=2⟩ [Accessed 25 June 2016].
[59] *CarpathCC* - In-depth Assessment of Vulnerability to Climate Change and Ecosystem-Based Adaptation Measures in the Carpathian Region. Preparatory action Climate of the Carpathian Basin (2011–2013) ⟨http://www.carpathcc.eu⟩ [Accessed 25 June 2016].
[60] MEDIATION - Methodology for Effective Decision Making on AdaptaTION. FP7 (2007–2013) ⟨http://mediation-project.eu⟩ [Accessed 25 June 2016].
[61] *RSC*-Regions for Sustainable Change. Interreg IVC (2008–2011) ⟨http://www.rscproject.org⟩ [Accessed 25 June 2016].
[62] IPCC. Climate Change . Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth. In: Change ML, Parry OF, Canziani JP, Palutikof PJ, van der Linden , Hanson CE, editors. Assessment. Report of the Intergovernmental Panel on Climate. Cambridge, UK: Cambridge University Press; 2007.
[63] Climate-ADAPT - European Climate Adaptation Platform. National Adaptation Strategy – Austria ⟨http://climate-adapt.eea.europa.eu/metadata/publications/national-adaptation-strategy-austria⟩ [Accessed 10 June 2016].
[64] Austrian Carbon Calculator (ACC) – modelling soil carbon dynamics in Austrian soils. Project funded by the Klima- und Energiefonds; 2014.
[65] Dawson RJ, Flacke J, Salvia M, Pietrapertosa F. Understanding Cities: The imperative for integration. In Dawson RJ, Wyckmans A, Heidrich O, Köhler J, Dobson S and Feliu E editors. Understanding Cities: Advances in integrated assessment of urban sustainability, Final Report of COST Action TU0902. Newcastle: Centre for Earth Systems Engineering Research (CESER); 2014. p. 65-74. ISBN 978-0-9928437-0-0.
[66] Reckien D, Flacke J, De Gregorio Hurtado S, Salvia M, Heidrich O, Dawson RJ,

et al. Urban climate change response and the impact of climate networks in Europe. In Dawson RJ, Wyckmans A, Heidrich O, Köhler J, Dobson S and Feliu E editors. Understanding Cities: Advances in integrated assessment of urban sustainability, Final Report of COST Action TU0902. Newcastle: Centre for Earth Systems Engineering Research (CESER); 2014. p. 65-74. ISBN 978-0-9928437-0-0.

[67] Salvia M, Pietrapertosa F, De Gregorio Hurtado S, Geneletti D, D'Alonzo V, Di Leo S and Reckien D. Mitigating climate change in Italy: a cluster analysis of urban responses. In Dawson RJ, Wyckmans A, Heidrich O, Köhler J, Dobson S and Feliu E editors. Understanding Cities: Advances in integrated assessment of urban sustainability, Final Report of COST Action TU0902. Newcastle: Centre for Earth Systems Engineering Research (CESER); 2014. p. 65-74. ISBN 978-0-9928437-0-0.

[68] Olazabal M, De Gregorio S, Olazabal E, Pietrapertosa F, Salvia M, Geneletti D. et al. How are Italian and Spanish Cities are tackling climate change? A local comparative study. BC3 Working Paper Series 2014-03. Basque Centre for Climate Change (BC3). Bilbao, Spain; 2014.

[69] De Gregorio Hurtado S, Olazabal M, Salvia M, Pietrapertosa F, Olazabal E, Geneletti D. et al. Understanding how and why cities engage with climate policy. An analysis of local climate action in Spain and Italy. Tema. Journal of Land Use, Mobility and Environment. (Special Issue ECCA 2015); 8:23-46. doi. http://dx.doi.org/10.6092/1970-9870/3649.

[70] LIFE-LAKS EU project - Local Accountability for Kyoto Goals. ⟨http://space.comune.re.it/laks/web/⟩ [Accessed 18 July 2016].

[71] EU LIFE ACT project. ⟨http://www.actlife.eu/EN/index.xhtml⟩ [Accessed 18 July 2016].

[72] EU LIFE-BlueAp project. ⟨http://www.blueap.eu/⟩ [Accessed 18 July 2016].

[73] Mayors Adapt initiative. ⟨http://mayors-adapt.eu/⟩ [Accessed 8-12-2016].

[74] Covenant of Mayors. ⟨http://www.covenantofmayors.eu/index_en.html⟩ [Accessed 8-12-2016].

[75] Covenant of Mayors for Climate & Energy. ⟨http://www.covenantofmayors.eu/about/covenant-of-mayors_en.html⟩ [Accessed 8-12-2016].

[76] Victor D. Toward effective international cooperation on climate change: numbers, interests, and institutions. Glob Environ Polit 2006;6(3):90–103.

[77] Smeets E, Weterings R. Environmental indicators: Typology and Overview. European Environment Agency. 1999, Technical Report no.25.

[78] Bernauer T, Böhmelt T. National climate policies in international comparison: the climate change cooperation index. Environ Sci Policy 2013;25:196–206. http://dx.doi.org/10.1016/j.envsci.2012.09.007.

[79] Burck J, Bals C The climate change performance index. Background and methodology. Germanwatch, Climate Action Network Europe.

[80] Battig M, Brander S, Imboden D. Measuring countries' cooperation within the international climate change regime. Environ Sci Policy 2008;11(6):478–89.

[81] Lucia U, Grisolia G. Unavailability percentage as energy planning and economic choice parameter. Renew Sustain Energy Rev 2017;75:197–204. http://dx.doi.org/10.1016/j.rser.2016.10.064.